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LOCAL MIGRATION AND FEEDING HABITS OF CARPATHIAN LAMPREY *EUDONTOMYZON DANFORDI* (PETROMYZONTES: PETROMYZONTIDAE) IN TISZA RIVER SYSTEM (DANUBE DRAINAGE, UKRAINE)

E.M. Talabishka[1], N.G. Bogutskaya[2] and A.M. Naseka[2]*

[1]*Transcarpathian Salmonids and Endangered Fish Reproduction Research Station of Institute of Fisheries of Ukrainian National Academy of Agrarian Science, Uzhgorodska Str. 165, 89600 Mukachevo, Ukraine; e-mail: talabishka@online.ua*

[2]*Zoological Institute of the Russian Academy of Sciences, Universitetskaya Emb. 1, 199034 Saint Petersburg, Russia; e-mail: dr_naseka@rambler.ru*

ABSTRACT

The paper presents data on the feeding habits and migratory activity of Carpathian lamprey *Eudontomyzon danfordi* Regan, 1911, one of the few predatory lampreys resident in rivers. Observations made in winter revealed some feeding activity though it was commonly supposed that the lampreys cease feeding by the end of autumn. The most intensive feeding occurs from May till August; during the same period, the lampreys actively migrate upstream. Observations made at the rapids revealed that *E. danfordi* actively preys and feeds during day time when and where the concentration of its prey is high, not only in the evening or at night as was believed earlier.

Key words: fecundity, feeding, migrations, parasitic lampreys

О ЛОКАЛЬНОЙ МИГРАЦИИ И ПИТАНИИ КАРПАТСКОЙ МИНОГИ *EUDONTOMYZON DANFORDI* (PETROMYZONTES: PETROMYZONTIDAE) В СИСТЕМЕ РЕКИ ТИССЫ (БАССЕЙН ДУНАЯ, УКРАИНА)

Е.М. Талабишка[1], Н.Г. Богуцкая[2] и А.М. Насека[2]*

[1]*Закарпатская научно-исследовательская станция лососеводства и воспроизводства исчезающих видов рыб Института рыбного хозяйства Национальной академии аграрных наук Украины, Ужгородская ул. 165, 89600 Мукачево, Украина; e-mail: talabishka@online.ua*

[2]*Зоологический институт Российской академии наук, Университетская наб. 1, 199034 Санкт-Петербург, Россия; e-mail: dr_naseka@rambler.ru*

РЕЗЮМЕ

В статье представлены данные наблюдений за пищевой и миграционной активностью взрослых особей карпатской миноги *Eudontomyzon danfordi* Regan, 1911, которая является одним из немногих видов жилых паразитических миног. В отличие от данных из литературы, отмечавших прекращение питания в конце осени, показано, что минога продолжает питаться и зимой, хотя и менее активно. Пик пищевой активности наблюдается в мае–августе; в этот же период минога активно мигрирует вверх по течению. Наблюдения на порогах впервые показали, что карпатская минога активно охотится и питается не только вечером и ночью, но и в дневное время в местах концентрации доступных пищевых объектов.

Ключевые слова: плодовитость, питание, миграции, паразитические миноги

**Corresponding author / Автор-корреспондент*

INTRODUCTION

Lampreys (Petromyzontidae Bonaparte, 1831) are a group of primitive vertebrates, that includes anadromous, landlocked, and purely freshwater taxa. Over half of the known species are non-parasitic, or brook forms, which never feed during their brief adult lives. The remainder feed as adults in a parasitic, or more correctly, predatory manner in the case of Carpathian lamprey *Eudontomyzon danfordi* Regan, 1911, mainly on teleost fishes (Hardisty 1986a). *Eudontomyzon danfordi* is an endemic species distributed only in the left-hand tributaries of the Lower Danube – Tisza, Timiş, Cerna, and, probably, Nera (Bănărescu 1969; Renaud and Holčík 1986). The first record of *E. danfordi* in the upper Tisza River system (in the area of the Transcarpathian Province of the present-day Ukraine) belongs to Vladykov (1925, 1926), who described it as a new species *Lampetra bergi* that was synonymised with *E. danfordi* in a subsequent publication (Vladykov 1931). Details of its distribution in the Ukrainian part of the Tisza River system and adjacent Romanian territory can be found in a number of publications (Vlasova 1956; Kolyushev 1949, 1959; Movchan 1993, 2000, 2005, 2009; Harka and Bănărescu 1999; Koŝĉo et al. 2004; Harka 2006).

Eudontomyzon danfordi is one of the few predatory lampreys that do not migrate to sea or a large lake during their adult stage. Some data on its ecology can be found in two summarising publications (Renaud and Holčík 1986; Renaud 2011). However, there are still many aspects to be investigated with regards to its feeding habits, migratory activity and spawning. In this paper we present data on feeding and migration of adult Carpathian lamprey in the Tisza River system.

MATERIAL AND METHODS

Field observations and collections were made by the first author in 2004–2009 in the Vecha River (a left-hand tributary of the Latorica River in the Tisza system) along a one kilometre long stretch of the river, where a shallow riffle section is located (48°34´2´´N 23°2´38´´E). In this section, occurrence of *E. danfordi* was monitored daily from early spring till late autumn, and also in winter, but more intermittently. In summer, observations were also done along the whole Vecha River as well as in adjacent Latorica River sections and in the Tisza River in 2004–2010. Observations of migratory activity of Carpathian lamprey and other fishes were made at the rapids, where rocks of a considerable size (Fig. 1) impede their movement. Shallow water in the monitored sections of the river made it possible to visually observe the lampreys' movements and feeding as well as conditions and movements of its prey. Some observations on feeding habits were performed in an aquarium; all lamprey individuals were then released back into the river. A few samples were fixed in 4% formalin and deposited in the fish collection of the National Museum of Natural History of the National Academy of Sciences of Ukraine in Kiev (NHMU).

RESULTS

Description of adult *E. danfordi*. Observed individuals were adult post-metamorphosed pre-spawning lamprey in the parasitic phase of the life cycle judging by morphological characters summarised, for example, in Renaud and Holčík (1986). The size of the lamprey increases from spring to the end of summer. In a sample (NHMU No 8650) collected on May 23, 2007 at the Vecha River rapids, the total length of 10 specimens is 169–230 mm and the weight is 6.1–13.2 g (Table 1); the gonads were poorly developed, and their sex could not be determined. A sample (NHMU No 8647), collected on August 20, 2005 at the same locality, includes five females (Table 2) 199–270 mm long with well-developed gonads and clearly distinguishable oocytes. The gonado-somatic index in three of the females was 4.6, 4.7, and 5.6%. However, in two of the females it was difficult to determine with any accuracy the number of eggs because of their smaller size. All measurements were made after fixation in formalin. Specimens in both samples possess well-developed intestinal tracts entirely filled up with food remains.

Migration. The rapids were used as an observation point to examine the direction of the lampreys' movement along the river. A pronounced downstream migration, if it occurs, was not observed. An active run upstream of relatively large schools of lamprey was recorded at the rapids from May till August with the peak in June. The earliest appearance of lamprey was recorded on May 23; the latest record was on August 22 (both in 2007). During the period May–August, water temperature varied from

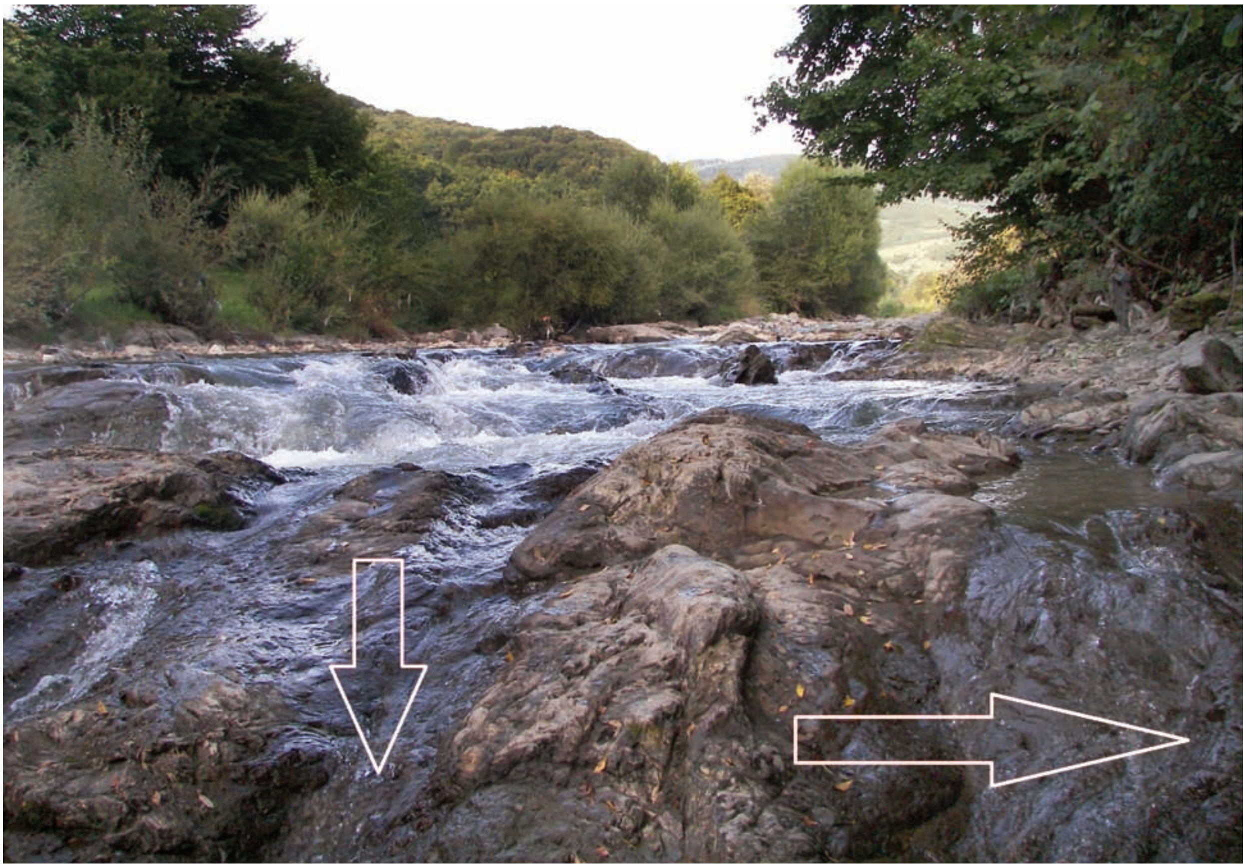


Fig. 1. Rapids on Vecha River (48°34'2"N 23°2'38"E) – main locality of observations. Arrows show two points, where Carpathian lamprey moves upstream.

13.5 to 17 °C, and water transparency was between 5 and 150 cm. Because of heavy rains, the migration started much later in 2006, when both bony fishes and lamprey began overcoming the rapids only in the middle of summer. In general, the migration of the lamprey coincides with that of other fishes. However, in 2006, when the run started only on July 20th, the first fishes that appeared at the rapids were several individuals of minnow and bullhead; the following day many more fishes came through, but no lamprey was recorded during an hour of observations. On the third day of the migration there were already many fishes and lampreys at the rapids.

Diurnal activity was rather stable; lamprey individuals coming upstream were commonly recorded throughout the whole day with a peak from 14:00–15:00 until 17:00. However, during the evening and night the movement activity was minimal or absent. During the peak of the migration, there could be seen

Table 1. Total length and weight of *Eudontomyzon danfordi* adults, Vecha River, May 23, 2007.

No	Total length, mm	Body weight, g
1	169.0	6.1
2	171.4	8.3
3	191.3	8.5
4	230.0	12.4
5	215.2	11.7
6	204.4	12.5
7	218.1	13.2
8	216.9	11.0
9	200.7	9.7
10	205.5	10.5

Table 2. Data on *Eudontomyzon danfordi* females, Vecha River, August 20, 2005.

No	Total length, mm	Intestine external diameter, mm	Body weight, g	Weight of gonads, g	Absolute fecundity, eggs	Relative fecundity, eggs per 1 g of body weight
1	270.0	3.0	33.3	1.88	19390	582
2	257.3	5.2	26.6	1.26	12300	462
3	231.7	4.4	18.4	0.85	8770	477
4	243.0	6.1	22.9	0.67	–	–
5	199.0	4.0	14.3	0.15	–	–



Fig. 2. Carpathian lamprey attached to rocks while running upstream over rapids.

up to 13 individuals during 15 minutes, up to seven simultaneously.

For getting over the barrier, *E. danfordi* uses its oral disc for attachment to rocks. First, a lamprey swims rapidly to a higher place on a rock and attaches to it, then, after some time, it swims further upstream, reaching another rock or moving to a deeper place under rocks from where it reappears later to attach to another rock located further upstream. The lampreys often climb out of the water onto wet rocks and crawl in an upstream direction along the cracks in rocks in order to overcome an obstacle. Sometimes, up to four or five *E. danfordi* individuals could be seen attached together on a single rock in very shallow water with a high velocity (Fig. 2). They could be easily taken by hand. After overcoming the rapids, lamprey swim fast upstream to deeper places of the river bed.

Feeding habits. Our observations show that adult *E. danfordi* feed during the entire year of their feeding phase. However, there are limitations to com-

parisons between seasons because our observations were dependent on weather and water conditions; flooding and high water turbidity prevented us from conducting observations in the early spring at the same level as during the rest of the year. The peak of feeding (the greatest number of prey collected and feeding lamprey observed) was in late May–August; the earliest record of several intensively feeding post-metamorphosed individuals was done at night May 1–2, 2010, in the Tisza River. In September–November the feeding activity declined to a very low level. Thus, in November only three fishes partly eaten by lamprey were collected. In December–beginning of March, few observations of feeding lamprey were done or prey found.

During the daily excursions along the investigated section of the river, excluding the rapids, prey of the lamprey were only found in the morning and never during the second inspection of the same river section in the afternoon. This probably indicates that the lampreys feed during the night or early morning, and that the prey were then swept downstream with the current. Additionally, there were observations made at night in Vecha and Latorica rivers of feeding lamprey in different biotopes, from quiet shallows to riffles with exposed rock, but usually in sections between calm water and fast current. The attached lamprey did not react to scattered light but, when illuminated by bright torch light, immediately detached from the prey and tried to hide under a stone or in a deeper place.

The only exception to this feeding behaviour was at the rapids on the Vecha River, where many lamprey individuals were observed preying upon other fishes during the day time while migrating upstream.

When an individual of *E. danfordi* was hunting, it swam slowly in the water column mostly near the bottom, but when approaching a prey it rapidly attacked the fish and attached to any part of the body. Then it usually slowly moved to the prey's abdomen, penetrated the body cavity, and started sucking the blood while simultaneously eating the heart and other visceral organs. This mode of predation was also demonstrated in the aquarium. If there were a lot of fishes concentrated at the rapids, lampreys left their prey without eating the muscular tissue (Fig. 3A) or ate the muscles and skin only just behind the head (Fig. 3B, C). Some lampreys moved more actively and attacked any nearby prey, consuming even their vertebrae (Fig. 3D). However, *E. danfordi* never ate the entire fish – they usually left the head and the vertebral column intact (Fig. 3E). Carpathian lamprey often hunted at places with high water velocity, where prey were more vulnerable. After a successful attack, a lamprey swam with its prey to an adjacent part of the river with a slowed current. Several times two individuals of *E. danfordi* were observed eating and fighting over the same fish. However, the lamprey never exhibited agonistic behavior towards each other.

We observed Carpathian lamprey preying upon the following fish species: *Alburnoides bipunctatus* (Bloch, 1782), *Squalius cephalus* (Linnaeus, 1758), *Barbus carpathicus* Kotlik, Tsigenopoulos, Ráb and Berrebi, 2002, *Chondrostoma nasus* (Linnaeus, 1758), *Cottus gobio* Linnaeus, 1758, *Cottus poecilopus* Heckel, 1837, *Barbatula barbatula* (Linnaeus, 1758), *Phoxinus phoxinus* (Linnaeus, 1758), and *Gobio carpathicus* Vladykov, 1925. At the rapids, the most common prey are *P. phoxinus, C. poecilopus, B. carpathicus* and *B. barbatula*. In the fish farm ponds on the Krasna River (a tributary of the Teresva River), the lamprey feeds on rainbow trout *Oncorhynchus mykiss* (Walbaum, 1792).

DISCUSSION

Our data on fecundity and gonad weight in *E. danfordi*, though limited, may be useful for comparisons with other lamprey species. In our study, the absolute fecundity in a 270 mm long female collected in August was 19,390 eggs, much higher than the count given in the literature. Hardisty (1964) reported the estimated absolute fecundity of *E. danfordi* to be 7,500 to 10,350 eggs in females of 210–215 mm in total length. The absolute fecundity in adult *E. danfordi* is higher than in other resident but non-parasitic lampreys: 573–2,175 in *Lampetra planeri* (Bloch, 1784) reported in Hardisty (1986a, 1986c) and 1,950–7,106 in *Eudontomyzon mariae* (Berg, 1931) reported in Holčík and Renaud (1986), but lower that in the anadromous parasitic lampreys: 4,000–42,500 in *Lampetra fluviatilis* (Linnaeus, 1758) reported in Hardisty (1986b). It is interesting that a rather similar absolute fecundity of 10,000–16,000 was found in the landlocked parasitic morph *ladogensis* of *L. fluviatilis* (Ivanova-Berg 1933). In the literature, we found no data on relative fecundity in *E. danfordi*; in three other freshwater (resident) parasitic lampreys, *Tetrapleurodon spadiceus*, landlocked *Petromyzon marinus* and *Ichthyomyzon unicuspis* the estimated



Fig. 3. Prey of Carpathian lamprey: A, C – *Barbus carpathicus*; B – *Phoxinus phoxinus*; D – *Alburnoides bipunctatus*; E – *Cottus poecilopus*.

relative fecundity was respectively, 318, 344 and 410 eggs per g body weight (Hardisty 1971, 1986a). Our estimates of 462–582 for *E. danfordi* are thus significantly higher than those reported for other resident parasitic species and closer to estimates found in non-parasitic species (Hardisty 1986a).

When compared with data of previous authors summarised in Renaud and Holčík (1986), our observations confirm the fact that the adult trophic phase in *E. danfordi* lasts for most of the first year of adult life. However, our observations of some winter feeding activity, albeit at a reduced level, is contrary to the observations of some authors, who found that after October or November the intestine atrophies and adults cease feeding (Mihail 1962a, 1962b; Kux 1965). It was supposed that the prey are usually attacked in the evening or at night (Renaud and Holčík 1986); our data revealed that *E. danfordi* also actively prey and feed during the day time when and where the concentration of its prey is high.

Chappuis (1939), Grossu et al. (1962), Holčík (1963), and Bănărescu (1969) reported that *E. danfordi* fed on *Barbatula barbatula*, *Barbus barbus* (Linnaeus, 1758), *B. petenyi* (recently described as *B. carpathicus* in the area in consideration), *Cottus gobio*, *C. poecilopus*, *Salmo* sp., and *Squalius cephalus*. Other species known to be attacked by *E. danfordi* in aquaria (Kux 1967) are *Carasssius carassius* (Linnaeus, 1758), *Gobio gobio* (now *G. carpathicus* in the area in consideration), *Phoxinus phoxinus* and *Rutilus rutilus* (Linnaeus, 1758). Therefore, *A. bipunctatus* and *C. nasus* are reported here as prey for the first time.

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